

CLAIMS

What is claimed is:

1. A system for generating a slow-rise waveform to deliver defibrillation energy to terminate a cardiac fibrillation condition, the system comprising:
 - means for generating a slow-rise waveform to an predetermined amplitude;
 - means for converting the slow-rise waveform to an exponential decaying waveform for a predetermined period of time; and
 - means for truncating said slow-rise waveform upon the expiration of the predetermined period of time.
2. A system according to claim 1, wherein said slow-rise waveform comprises a one of the following:
 - a ramp-up waveform V , wherein $V = mt$,
 - an exponential rise waveform V , wherein $V = \exp(t / \tau)$,
 - an exponential approach waveform V , wherein $V = 1 - \exp(-t / \tau)$;and
wherein said means for generating said slow-rise waveform comprises a switching power converter in operable electrical communication with at least one storage capacitor cell.
3. A system according to claim 2, wherein said exponential decaying waveform is truncated to a nominal voltage at a predetermined time.
4. A system according to claim 3, further comprising a second waveform having polarity opposite to the slow-rise waveform and means for transitioning from said slow-rise waveform to said second waveform at a predetermined time.

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5. A system according to claim 1, wherein said means for generating the slow-rise waveform includes a pulse-modulating circuit.
6. A system according to claim 1, wherein said means for generating a slow-rise waveform to an predetermined amplitude includes an initial, relatively low amplitude step function from which the slow-rise waveform proceeds.
7. A system according to claim 4, wherein the second waveform comprises a lower amplitude slow-rise waveform.
8. A system according to claim 1, wherein the exponential decaying portion of the slow-rise waveform comprises an unmodulated capacitor discharge time function.
9. A system according to claim 1, further comprising at least pair of defibrillation electrode assemblies electrically coupled to the system at a proximal end and electrically coupled to a portion of cardiac tissue near a distal end portion and wherein said pair of assemblies includes at least one of the following: a percutaneous electrode, a subcutaneous electrode, an epicardial electrode, an endocardial electrode, a pericardial electrode, a transcutaneous electrode, a surface electrode, a canister electrode, a coil electrode, a ring electrode.
10. A system according to claim 4, wherein said slow-rise waveform includes a characteristic tilt of between approximately 50% and 75%.
11. A system according to claim 10, wherein said second waveform includes a characteristic tilt of between approximately 50% and 75%.

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12. A system according to claim 4, wherein said second includes an initial, relatively low amplitude step function and said second waveform has a characteristic tilt of between approximately 50% and 75%.
13. A system according to claim 12, wherein said second waveform comprises a second slow-rise waveform following said initial, relatively low amplitude step function.
14. A system according to claim 13, wherein said second slow-rise waveform is followed by an exponential decay portion which in turn is followed by a truncated portion.
15. A method of delivering at least one complex defibrillation waveform to a portion of cardiac tissue, comprising the steps:
 - confirming the presence of a cardiac arrhythmia terminable by delivery of a defibrillation waveform;
 - generating at least one pulse-modulated slow-rise defibrillation waveform portion until said slow-rise defibrillation waveform portion reaches a predetermined amplitude;
 - allowing the amplitude of the defibrillation waveform to decay exponentially for either a predefined period of time or until a predetermined voltage threshold is reached;
 - truncating said defibrillation waveform; and
 - providing said defibrillation waveform to a portion of cardiac tissue.
16. A method according to claim 15, further comprising the steps:
 - after the truncating step, generating a second defibrillation waveform of opposite polarity to said at least one pulse-modulated slow-rise defibrillation waveform; and
 - providing said second defibrillation waveform to the portion of cardiac tissue.

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17. A method according to claim 16, wherein said second defibrillation waveform comprises an initial slow-rise defibrillation waveform portion.
18. A method according to claim 17, wherein said initial slow-rise defibrillation waveform portion is followed by an exponentially decaying portion, and said decaying portion if followed by a truncated portion.
19. A method according to claim 15, further comprising the steps of determining whether the cardiac arrhythmia has terminated, and if not, repeating the steps of claim 15 at a higher magnitude predetermined amplitude.
20. A method according to claim 15, further comprising the initial step of generating a relatively low amplitude step function prior to generating the pulse-generated slow-rise defibrillation waveform, and wherein said pulse-generated slow-rise waveform is generated beginning from the relatively low amplitude step function.
21. A method according to claim 15, wherein a total duration of said defibrillation waveform includes a range of approximately 13 ms to approximately 28 ms.
22. A method according to claim 15, wherein said pulse-modulated slow-rise waveform is generated by a high speed, power switching converter.
23. A method according to claim 22, wherein the slow-rise defibrillation waveform includes one of a voltage-controlled waveform and a current-controlled waveform.
24. A computer readable medium for storing executable instructions for performing a method of delivering at least one complex defibrillation waveform to a portion of cardiac tissue, comprising:

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instructions for confirming the presence of a cardiac arrhythmia terminable by delivery of a defibrillation waveform; instructions for generating at least one pulse-modulated slow-rise defibrillation waveform portion until said slow-rise defibrillation waveform portion reaches a predetermined amplitude; instructions for allowing the amplitude of the defibrillation waveform to decay exponentially for either a predefined period of time or until a predetermined voltage threshold is reached; instructions for truncating said defibrillation waveform; and instructions for providing said defibrillation waveform to a portion of cardiac tissue.

25. A medium according to claim 24, further comprising:
after the truncating step, instructions for generating a second defibrillation waveform of opposite polarity to said at least one pulse-modulated slow-rise defibrillation waveform; and instructions for providing said second defibrillation waveform to the portion of cardiac tissue.
26. A medium according to claim 25, wherein said second defibrillation waveform comprises an initial slow-rise defibrillation waveform portion.
27. A medium according to claim 26, wherein said initial slow-rise defibrillation waveform portion includes a segment followed by an exponentially decaying portion, and said decaying portion includes a segment followed by a truncated portion.
28. A medium according to claim 24, further comprising:
instructions for determining if the cardiac arrhythmia has terminated, and if not, instructions for repeating the steps of claim 24 at a higher magnitude predetermined amplitude.

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29. A medium according to claim 24, further comprising:
instructions for generating a relatively low amplitude step function prior to generating the pulse-generated slow-rise defibrillation waveform, and wherein said pulse-generated slow-rise waveform is generated beginning from the relatively low amplitude step function.
30. A medium according to claim 24, wherein a total duration of said defibrillation waveform is in the range of approximately 13 ms to approximately 28 ms.
31. A medium according to claim 24, wherein said pulse-modulated slow-rise waveform is generated by a high speed, power switching converter.
32. A method according to claim 31, wherein the slow-rise defibrillation waveform is either a voltage-controlled waveform or a current-controlled waveform.